[001] METHOD FOR THE CONTROL OF A DRIVE TRAIN

[002]

[003]

[004] The invention relates to a method for controlling a drive train of the type defined in more detail in the preamble of Claim 1.

[005]

[006] The invention relates to working vehicles such as wheel loaders, baggers or floor-level conveyor vehicles, whose driving direction during work changes at short time intervals and which frequently have to be driven backward. This frequent driving direction change is also known as reversing. In this, the vehicle moving at full driving speed in a forward driving direction is braked by engaging the reverse gear and then accelerated in a backward driving direction. The vehicle's change of driving direction begins with the opening of the driving direction clutch of the existing driving direction and the closing of the driving direction clutch of the new driving direction. During this change, the turbine side of the hydrodynamic torque converter is slowed down or made to reverse its rotation direction, depending on the force transfer of the forward or backward driving clutch. During this, the pump side of the hydrodynamic torque converter is supported by the drive engine. The deceleration and acceleration times of the vehicle can be influenced by the power of the drive engine, the characteristics of the hydrodynamic torque converter and the slippage time of the driving direction clutches. However, this is only possible in limited measure, since the extent to which the driving direction clutches can be loaded is limited.

[007] DE 30 23 278 C2 discloses a method for the control of a force transfer mechanism, in which the deceleration time is influenced by changing the transmission ratio of the speed-shift transmission when changing the driving direction. It is not possible to change between the driving direction clutches at a high speed.

[008] The purpose of the present invention is to provide a method for controlling a drive train in which frequent driving direction changes, even from high driving

speeds are possible and the deceleration and acceleration times can be influenced according to need.

[009] This objective is achieved by a method for the control of a drive train of the type described, which also embodies the characterizing features of the principal claim.

[010]

[011] A clutch connects the drive engine to the pump of the hydrodynamic torque converter according to the invention. During a driving direction change, this clutch is actuated in the opening direction in a controlled way, so that clutch slip occurs. Depending on the control of the clutch, the deceleration or acceleration time can be influenced. Preferably, the speed of the drive engine is not reduced during the direction change. In a controlled way, it is possible to carry out a hard reversing process, i.e., one with a short reversing time or a soft reversing process, i.e., one with a longer reversing time and to regulate the clutch accordingly. It is also possible to determine the actual deceleration as a function of a predetermined deceleration gradient which can be done, for example, by means of a rotation speed sensor on the drive output of the turnover gear and to regulate the clutch so that the deceleration or acceleration gradient determined approximates the preselected value. Likewise, the clutch can be controlled in such a way that specified operating parameters of the hydrodynamic converter or the driving direction clutches, such as the oil temperature or calculated friction performances, are not exceeded in order to protect the hydrodynamic converter or the driving direction clutches from damage.

[012] This provides a method for the control of a drive train, and a drive train in which frequent reversing is possible with various deceleration and acceleration values, in particular, for working machines. The speed of the drive engine can remain high during the reversing process, so that when accelerating the vehicle in the new driving direction the drive engine can be quickly operated at full power without first having to be slowly accelerated to high speeds. In this way, the acceleration process can be made considerably shorter. It is also possible to

carry out a soft reverse over a longer time without damaging the components of the drive train and so to reverse gently, for example, in the case of a wheel loader carrying very light bulky material or a floor-level conveyor vehicle, in particular one with a raised load. In addition, independent of the speed of the drive engine, it is also possible to carry out the reversing process in such a manner as, for example, to make maximum power available during the reversing process to the working hydraulic system which is directly connected to the drive engine. This is made possible by reducing the load on the driving direction clutches as a result of clutch slip between the drive engine and the hydrodynamic torque converter. Consequently, the driving direction clutches can also be made much more compact. In another embodiment, it is possible to influence the deceleration and acceleration time by acting upon the clutch between the drive engine and the hydrodynamic torque converter.

[013]

[014] Further characteristics emerge from the description of the figure.

[015]

[016]

[017] The single Figure shows a drive engine 1, which is connected to a pump 3 of a hydrodynamic torque converter 4 via a clutch 2. The drive engine 1 is directly connected to a hydraulic pump 5, which supplies a consumer 7 with pressure fluid via valves 6. An electronic control unit 8 regulates the clutch 2 as a function of signals from sensors in a service brake 9, an accelerator pedal 10, an operating lever 11 and speed sensors 12. The drive output of the hydrodynamic torque converter 4 is connected to a reversing transmission 13, preferably a change-under-load reversing transmission 13 with several gear steps, which is in connection with the drive wheels of the mobile vehicle. During the reversing process, the driving direction clutches (not shown) in the reversing transmission 13 are manipulated in such a manner that the driving direction clutch for the new driving direction is actuated in the closing direction and the driving direction clutch

for the old driving direction is actuated in the opening direction. At the same time, the electronic control unit 8 regulates the clutch 2 so that, depending on the desired deceleration or acceleration values, the vehicle is braked in the existing driving direction and accelerated in the new driving direction. During this reversing process, it is possible not to reduce the speed of the drive engine 1, so that the hydraulic pump 5 can continue being driven with a sufficiently high speed. Likewise, the reversing time can be varied as a function of the regulation of the clutch 2, so as to carry out a soft or a hard reversing process.

Reference numerals

1	Drive engine
2	Clutch
3	Pump
4	Hydrodynamic torque converter
5	Hydraulic pump
6	Valve
7	Consumer
8	Electronic control unit
9	Service brake
10	Accelerator pedal
11	Operating lever
12	Speed sensors
13	Reversing transmission